ON TWO SPECIES OF *EPILACHNA* (COLEOPTERA : COCCINELLIDAE) FROM AUSTRALIA.

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(Six Text-figures.)

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Synopsis.

Genitalia studies by Dieke (1947) have indicated that phytophagous coccinellid beetles, generally regarded in Australia as belonging to a single species, *Epilachna 28-punctata*, may in fact be referred to three separate species, namely, *Epilachna 28-punctata* (Fabricius), *Epilachna sparsa* (Herbst) subsp. *26-punctata* (Boisduval), and *Epilachna philippinensis* subsp. *australica* (Dieke). Biological studies on the first two species have confirmed their separate identity, and the characteristic differences of the immature stages have been described. Although the two species mated readily, eggs obtained from such cross matings were infertile. Although the larvae of *E. sparsa* fed on cucumber, this species was otherwise generally associated with the Solanaceae, while *E. 28-punctata* was associated with the Cucurbitaceae.

Introduction.

The genus *Epilachna* is of considerable economic importance, but many doubts still exist concerning the taxonomy and biology of the species found in Australia and the Pacific area (Dieke, 1947). Formerly it was considered that certain spotted beetles of this genus, the larvae and adults of which attack Cucurbitaceae and Solanaceae in Australia, belonged to a single species, *Epilachna 28-punctata* (Fabricius), which showed some variation in external morphology and utilized a wide range of host plants (Temperley, 1928). The studies of Dieke (Dieke, 1947), however, based on an examination of the male and female genitalia, indicated that at least three separate species were likely to be involved, namely, *Epilachna 28-punctata* (Fabricius), *Epilachna sparsa* (Herbst) subsp. *26-punctata* (Boisduval) and *Epilachna philippinensis* subsp. *australica* Dieke. The present paper is concerned with the first two of these species. There is some doubt regarding the correct nomenclature for these species as the type specimens have not been preserved and the original descriptions are too generalized to identify the species with certainty (Dieke, 1947). In this paper, Dieke's nomenclature has been followed as his studies of the genitalia allow the species to be recognized with reasonable certainty. This nomenclature runs contrary to that used by certain other workers. Thus the *E. 28-punctata* of Temperley (1928) is the *E. sparsa* subsp. *26-punctata* of this paper, and the *E. 28-punctata* of this paper is not the *E. vigintioctopunctata* of Kapur's paper on the larval stages of *Epilachna* (Kapur, 1951). The fourth instar larva described here under *E. sparsa* subsp. *26-punctata* agrees closely with that described by Kapur under *E. vigintioctopunctata*, and it is probable that they are the same species. Perhaps the minor differences noted are associated with the Australian subspecies.

The details of structure and biology presented here were obtained from insects collected in the Brisbane area and maintained in laboratory cultures at Samford, and may not necessarily apply throughout the entire range of the species. Preserved specimens from these cultures have been lodged in the collection of the Division of Entomology, C.S.I.R.O., Canberra.

Details of the known distribution of the two species have been given by Dieke. *E. 28-punctata* occurs from Ceylon through New Guinea and Australia to the South Pacific Islands. The various subspecies of *E. sparsa* have been recorded in Asia from

India to North China and Japan, Indonesia, Australia, and the South Pacific Islands. The subspecies *E. sparsa* subsp. *26-punctata* is found in the eastern part of this range from Australia and New Guinea to the South Pacific Islands.

The Adult Beetles.

The adult beetles have been described by Dieke from preserved specimens. A darkening that occurs rapidly after death probably explains Dieke's description of the ground colour as being red. In living specimens it is a dull yellow-orange. The development of the elytral spots of Samford specimens was reasonably constant within the species, the chief difference being the absence of the anterior spot at the base of the elytron in *E. sparsa* subsp. *26-punctata*. This spot was present in all the *E. 28-punctata* examined from Brisbane, but according to Dieke it is sometimes absent in specimens of this species taken in northern Australia. In *E. sparsa* subsp. *26-punctata* there is a tendency for the elytral spot 'g' (Fig. 1) to become enlarged and fuse with its fellow on the other elytron.

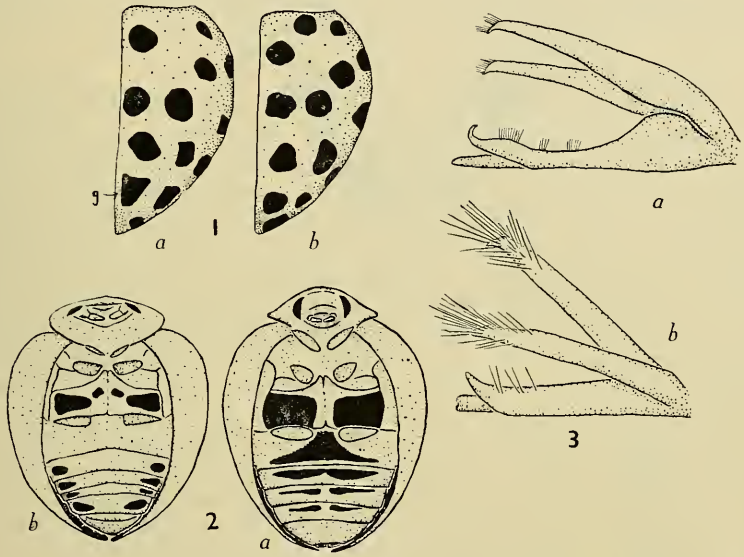


Fig. 1.—Elytral pattern of (*a*) *Epilachna sparsa* subsp. *26-punctata*; (*b*) *Epilachna 28-punctata.*

Fig. 2.—Ventral pattern of (*a*) *Epilachna sparsa* subsp. *26-punctata*; (*b*) *Epilachna 28-punctata.*

Fig. 3.—Male genitalia of (*a*) *Epilachna sparsa* subsp. *26-punctata*; (*b*) *Epilachna 28-punctata.*

Although both species showed considerable variation in the extent of the black markings on the underside, the examples given in Figure 2 are representative of the Samford cultures. In *E. 28-punctata* variation often involved a reduction of the number of black spots on the abdominal sternites and in extreme cases they were absent. In *E. sparsa* subsp. *26-punctata* any ventral abdominal markings consisted of a dark suffusion of the median areas of the sternites involved. Both species showed considerable variation in the development of the black patches on the metasternum.

Diagrams of the male genitalia are given in Figure 3.

Early Stages.

The *eggs* of the two species may be readily distinguished by their colour and arrangement within the egg mass. Those of *E. 28-punctata* are deep yellow and arranged loosely and irregularly in a single-layered egg mass; those of *E. sparsa* subsp. *26-punctata* are cream coloured and packed tightly together in an egg mass that is frequently

two-layered. Adult beetles, particularly of *E. 28-punctata*, eat their eggs readily, and successful cultures were obtained at Samford only by keeping small numbers of adults together, and by removing egg masses as soon as they were observed. When maintained at 85°F. the eggs hatched on the fourth day.

The newly hatched *larvae* of *E. 28-punctata* are golden in colour, while those of *E. sparsa* subsp. *26-punctata* are grey. This difference in coloration soon disappears when the larvae commence feeding, both species then being yellow. In later instars the larvae are bright yellow immediately after a moult, but become progressively darker during the instar. There are four larval instars, occupying a total of 17–18 days at 85°F.

The *pupae* of the two species may be readily separated by their colour, that of *E. sparsa* subsp. *26-punctata* being of a dirty white colour, suffused and clouded with grey, while that of *E. 28-punctata* is a pale yellow, flecked with brown and white markings. At 85°F. the pupal stage lasted for approximately six days.

Descriptions of Fourth Instar Larvae.

The terminology of Kapur (Kapur, 1951) has been used in the descriptions of the fourth instar larvae that follow.

A. E. sparsa subsp. 26-punctata.

Body. Elongate, oval, nearly three times as long as its maximum width.

Head. Subrounded, ochraceous, except for the pale yellow epicranial suture and the dark ocelli. The disposition of the ocelli and the larger setae is shown in Figure 4. Some variation occurs in the position of the setae in different specimens. The antenna is three-segmented (Fig. 5) with the third segment small but distinctly visible; second segment rather more than twice as long as its maximum width, carrying two or three lateral setae; third segment small, carrying sensillae. The mandible has five major teeth, the two apical teeth and the basal tooth being conspicuously denticulate (Fig. 5).

Thorax. Prothorax about twice as wide as long; pronotum oval, bordered posteriorly by a dark line, and carrying about 14 dark setae on the disc behind the prothoracic scoli; dorsal scolus as long as pronotum, with about 15 branches of which those at the base are shorter, paler, and more crowded than the others, each branch carrying a terminal spine and generally 2–5 fine lateral setae; subdorsal scolus slender, approximately as long as stem of dorsal scolus, with no branches, but carrying a slender apical seta about half the length of the scolus, and 2–3 fine lateral setae; dorsolateral scolus somewhat larger than the dorsal scolus, with about 25 branches generally similar in type and disposition to those of dorsal scolus. *Mesothorax* with dorsal and subdorsal scoli of same side arising from a common oval sclerotized area; dorsal scolus rather longer than that of prothorax and carrying about 19 branches of which those towards the base are shorter, paler, and more crowded than the others; subdorsal scolus longer than dorsal scolus and bearing about 22 branches; dorsolateral scolus similar to subdorsal scolus. *Metathorax* with scoli essentially similar to those of *mesothorax*.

Ventrally the *prothorax* has a single struma with 6–7 setae, *mesothorax* and *metathorax* with a pair of strumae, each with 6–7 setae.

Abdomen. On each of the first seven abdominal segments the two dorsal scoli arise from a single darkened, oval, sclerotized transverse elevation which has an unpigmented pit at each end; dorsal scoli carrying 12–14 branches of which about 6 are short and arise from the basal region. Subdorsal scoli somewhat longer than dorsal scoli and each rising from a separate sclerotized area which bears an unpigmented pit in its median border; branches approximately equal in number to those of dorsal scoli, but with a smaller proportion of the shorter basal type. Dorsolateral scoli with 12–14 branches on anterior segments of abdomen, but progressively reduced in size from the 4th to the 7th segment so that on latter is present only as a stunted scolus carrying 3–4 branches and several long setae. Scoli on 8th abdominal segment much reduced in size and with short branches or tubercles bearing long slender terminal setae, about 10–12 such setae on the dorsal scolus, and 13–15 on the subdorsal scolus (Fig. 6). Dorsolateral

scolus represented by a struma carrying 5–6 setae. Tergite of 9th abdominal segment semicircular, sclerotized, pale, and carrying about 12 long slender setae.

The ventral strumae of 1st abdominal segment lying close together and each carrying about 6 setae; those of the 2nd segment more widely separated, elongate, oval,

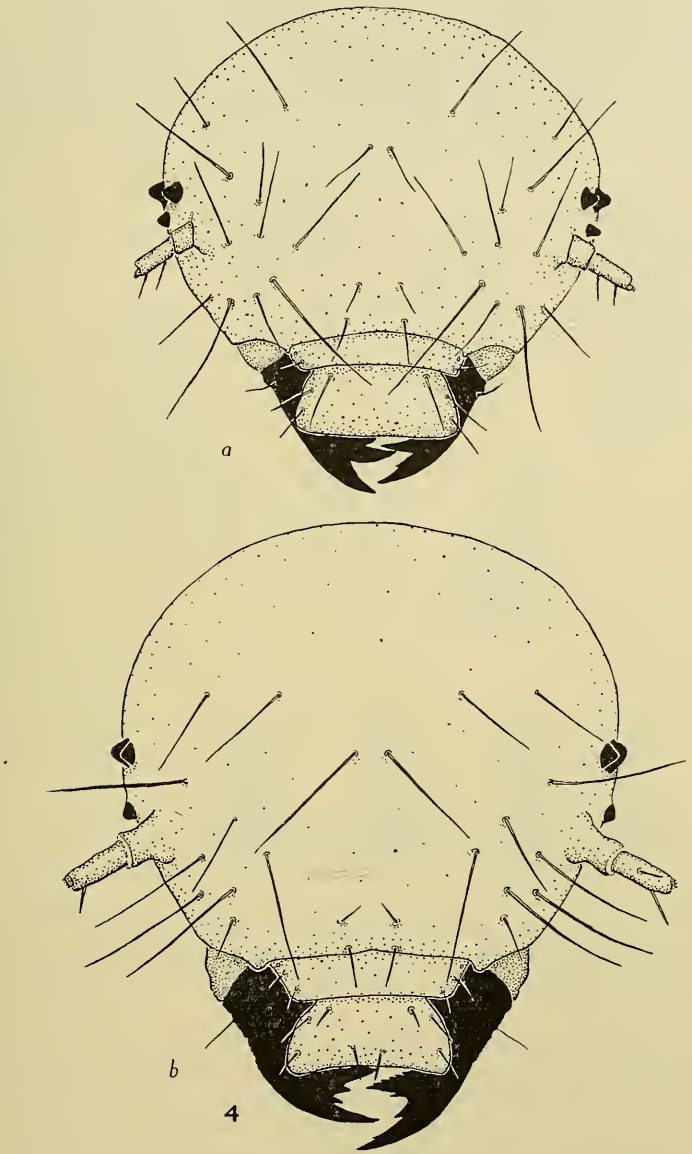


Fig. 4.—Head of 4th instar larva: (*a*) *Epilachna sparsa* subsp. *26-punctata*; (*b*) *Epilachna 28-punctata.*

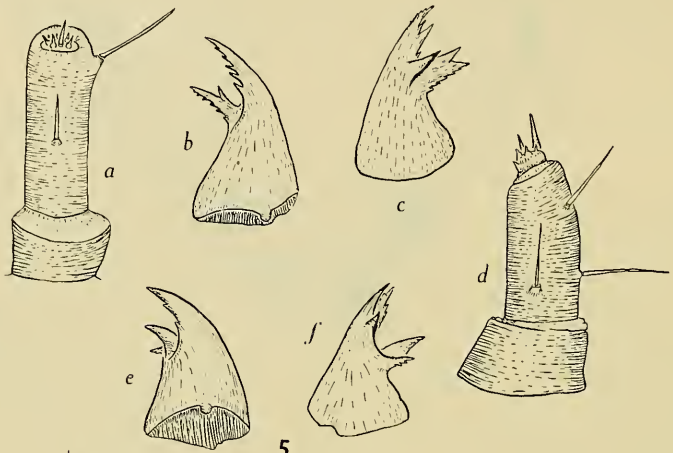
and with 5–7 setae of variable length; those of 3rd-5th segments clearly defined with 5–7 setae, these mostly long; those of 6th-8th segments smaller, with 3–4 setae, these mostly long. Subventral strumae absent on 1st segment; on 2nd segment small with 2–3 setae; on 3rd-7th segments rather similar to ventral strumae, but with longer setae and a more rounded shape; on 8th segment with 3 long setae. Ventrolateral strumae absent on 1st

abdominal segment; on 2nd segment well developed with 3–4 setae; on 3rd-7th segments larger with 5–7 setae; on 8th segment reduced with 3 long setae. Sternite of 9th segment with transverse row of 9–10 long setae.

B. E. 28-PUNCTATA.

Body. Elongate, oval, about three times as long as maximum width.

Head. Somewhat longer than in *E. sparsa* subsp. *26-punctata* and with longer setae, ochraceous (Fig. 4). Antenna 3-segmented, with 2nd segment nearly three times as long as its maximum width, and bearing 2–3 lateral setae; 3rd segment small disc-shaped (Fig. 5). Mandible with two major teeth and two minor teeth, strongly denticulate (Fig. 5).



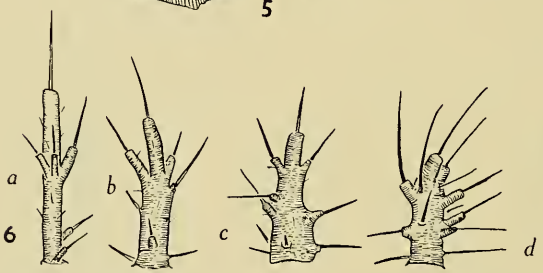


Fig. 5.—*Epilachna 28-punctata* (4th instar larva): (*a*) antenna; (*b, c*) mandible. *Epilachna sparsa* subsp. *26-punctata* (4th instar larva): (*d*) antenna; (*e, f*) mandible.

Fig. 6.—Scoli of 8th abdominal segment of 4th instar larvae. *Epilachna 28-punctata*: (*a*) dorsal scolus; (*b*) subdorsal scolus. *Epilachna sparsa* subsp. *26-punctata*: (*c*) dorsal scolus; (*d*) subdorsal scolus.

Thorax. Prothorax about twice as wide as long; pronotum oval, bordered posteriorly by a dark line and carrying 16–20 small setae on the disc behind the scoli; dorsal scolus somewhat longer than prothoracic tergum, with about 12 branches, with fewer short basal branches than in *E. sparsa* subsp. *26-punctata* and each branch having a terminal spine and 2–5 lateral setae; subdorsal scolus slender, shorter than stem of dorsal scolus, and bearing a terminal seta, somewhat less than half the length of the scolus, and several fine lateral setae; dorsolateral scolus somewhat larger than dorsal scolus and with 16–20 branches similar to those of latter. *Mesothorax* with dorsal and subdorsal scoli of same side arising close together from a common oval sclerotized area. Dorsal scolus approximately equal in length to that of prothorax and carrying 10–12 branches of which the basal 2–3 are short; subdorsal scolus rather longer than dorsal scolus and with about 15 branches; dorsolateral scolus similar to subdorsal scolus. *Metathorax* with scoli essentially similar to those of *mesothorax.*

Ventrally the *prothorax* has a single struma with 4–6 setae; *mesothorax* and *metathorax* each with a pair of strumae bearing 4–6 setae.

Abdomen. The scoli arise from sclerotized areas similar to those found in *E. sparsa* subsp. *26-punctata*. Dorsal scoli of first seven abdominal segments with 6–7 branches of moderate length and ending in setae, the basal short branches found in *E. sparsa* subsp. *26-punctata* being absent. Subdorsal scoli slightly longer than dorsal scoli, with 10–12 branches of which 2–3 belong to the shorter basal type. Dorsolateral scoli with 11–13 branches on anterior segments of abdomen, but progressively reduced in size from 4th to 7th segment so that on the latter it consists only of a single tubercle bearing a longer terminal seta and several shorter lateral setae. Scoli on 8th segment much reduced (Fig. 6), dorsal scolus with 4–6 branches, subdorsal with 6–8 branches, and dorsolateral represented by a single struma carrying 6–8 setae.

TABLE 1.

Acceptability of Various Plants to Larvae and Adults of E. 28-punctata *and* E. sparsa *subsp.* 26-punctata.

Foodplant.	*E. 28-punctata.*		*E. sparsa* subsp. *26-punctata.*	
	Larvae	Adult Beetle.	Larvae.	Adult Beetle.
Solanum nigrum	—	—	× × ×	× × ×
S. torvum	—	—	×	× ×
S. sodomaeum	—	—	× ×	× ×
S. auriculatum	—	—	×	×
S. seaforthianum	—	—	× × ×	× × ×
S. lycopersicum (Tomato)	—	—	× ×	× ×
S. tuberosum (Potato)	—	—	× × ×	× × ×
Physalis minima	—	—	× × ×	× × ×
P. peruviana	—	—	×	×
Datura arborea	—	—	× × ×	× × ×
D. stramonium	—	—	× × ×	× × ×
Petunia	—	—	×	×
Brunfelsia	—	—	× × ×	× × ×
Cucurbita pepo (Pumpkin)	× × ×	× × ×	—	—
Cucumis melo (Melon)	× × ×	× × ×	—	—
C. sativus (Cucumber)	× × ×	× × ×	× ×	—
Sechium edule (Choko)	×	× × ×	×	—
Gossypium (Cotton)	×	—	—	—
Phaseolus vulgaris (French Beans)	—	—	×	—
Vicia faba (Broad Beans)	× ×	—	—	—

× × ×, eaten readily; × ×, eaten readily by some individuals but refused by others; ×, eaten in small quantities by a few individuals but refused by remainder; —, not eaten.

Starvation conditions were only applied to the larva, the adults being left on the food-plants for only four days.

Ventral strumae of 1st abdominal segment rather closer together than those of succeeding segments, and carrying 3–4 setae; strumae on 2nd, 3rd-5th, and 6th-7th segments carrying 4–6, 5–7 and 3–4 setae respectively. Subventral strumae absent on 1st segment, well developed with 5–6 setae on 2nd, large with 7–10 setae on 3rd-6th segment, smaller with 4–5 setae on 7th segment. Ventrolateral strumae absent on 1st, with 4–5 setae on 2nd, and 6–8 setae on 3rd-7th segment. The ventral and subventral strumae of each side of the 8th sternite are fused together and each compound struma thus formed has about 4 long setae. The 9th abdominal sternite carries a row of 7–9 setae.

When identifying living larvae of the two species the most readily seen characters are the differences in the structure of the dorsal scoli of the anterior abdominal segments, and the dorsal and subdorsal scoli of the 8th abdominal segment.

FOODPLANTS.

The foodplant relationships of these two species are being investigated in some detail and the results will be published later. For the present, however, it seems desirable to publish the general feeding habits of the species since they are of economic significance. From the results summarized in Table 1 it will be seen that *E. 28-punctata*

feeds mainly on the Cucurbitaceae and *E. sparsa* subsp. *26-punctata* mainly on the Solanaceae. The only significant overlap in the host plant ranges of the two insects so far discovered is cucumber, which is eaten by some larvae of *E. sparsa* subsp. *26-punctata* but not by the adults. The status of *E. philippinensis* among the pest species of *Epilachna* in Australia is not known.

TABLE 2.

Results of Attempted Cross Fertilization of E. 28-punctata *and* E. sparsa *subsp.* 26-punctata.

Adult Beetles.	No. of Pairs in Separate Cages.	No. of Pairs in which Copulation Observed.	Batches of Eggs.	Batches Hatched.
♀ *sparsa* × ♂ *sparsa*	6	4	26	26
♀ *sparsa* × ♂ *28-punctata* ..	6	2	11	nil
♀ *28-punctata* × ♂ *sparsa* ..	8	5	29	nil
♀ *28-punctata* × ♂ *28-punctata* ..	6	6	23	23

INTERSPECIFIC MATING.

The separate identity of the two species was confirmed by the failure of attempts at cross fertilization.

The females of both species lay eggs irrespective of whether mating has occurred, and the males appear to mate readily with females of the other species. Virgin females were kept in individual cages, some with males of their own species and some with males of the other species. The results of the experiments are summarized in Table 2 and leave no doubt about the true specific status of the two species concerned.

Acknowledgements.

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